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(54) PLASTIC PIRN SLEEVES AND THEIR MANUFACTURE

(71) We, DU PONT OF CANADA LIMITED, a Corporation organised and existing under the laws of Canada, whose full post-office address is 555 Dorchester Boulevard, West, Montreal, Quebec, Canada, do hereby declare the invention for which we pray that a patent may be granted to us and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to plastic pirn sleeves and to a process and apparatus for producing rows of indentations in the external surface of thermoplastic tubing useful for making such sleeves.

Indentations in the external surface of thermoplastic tubing are required in various applications for utilitarian and for decorative purposes. One such application is in the production of plastic sleeves for textile bobbins or pirns as described in U.S. Patent 3,034,743. The indentations can take the form of circumferential grooves arranged in rows parallel to the axis, with intervening axial blank areas. These grooves and their associated "teeth", however, have ends which are raised above the surface of the intervening axial blanks. These exposed ends, unfortunately, can be ragged and entagle fine filaments jeopardizing smooth payout of filaments on high speed unwinding.

According to this invention there is provided a plastic pirn sleeve having the ends of grooves and "teeth" substantially flush at the juncture with the intervening axial blank areas. The pirn sleeves allow a smoother yarn take off tension which can be varied by varying the width and number of grooves rows. The invention also provides a non-entangling flush end grooved pirn sleeve that is adaptable to manufacture on a continuous and low cost basis.

According to one aspect of the invention, there is provided a plastic pirn sleeve which comprises a tube carrying at least two longitudinal rows of substantially circumferential grooves alternating with longitudinal blank areas, the grooves having a profile that is chordal, lunate, or lenticular with a maximum depth peak-to-valley of 0.002″ to 0.010″ and tapering at either end to be substantially flush with the blank areas, the grooves being spaced substantially uniformly to provide from 30 ot 70 grooves per inch, and the longitudinal rows being from 1/32″ to 1/2″ wide.

According to a second aspect of the invention there is provided a process for indenting the external surface of a thermoplastic tube, which comprises moving at least two die units each in a separate path along the length of the external surface of a thermoplastic tube while the tube is supported on a mandrel, and pressing the die units against the surface of the tube, whilst the tube is at a temperature above the softening point of the thermoplastic material, to form at least two longitudinal rows of permanent substantially circumferential grooves therein alternating with longitudinal blank areas, the grooves having a profile that is chordal, lunate, or lenticular with a maximum depth peak to valley of 0.002″ to 0.010″ and tapering at either end to be substantially flush with the blank areas, the grooves being spaced substantially uniformly to provide from 30 to 70 grooves per inch, and the longitudinal rows being from 1/32″ and 1/2″ wide.

According to a third aspect of the invention there is provided an apparatus for indenting the external surface of a thermoplastic tube, which comprises a mandrel and at least two rotatable die wheels located about the mandrel, the mandrel being adapted to support a thermoplastic tube, each

die wheel having a rim with indentations thereon and being adapted to roll on the surface of the tube in a longitudinal direction, and pressure means adapted to hold each wheel against the tube; the indentations being such that when the wheels roll against the surface of the thermoplastic tube, when the latter is at a temperature above the softening point of the thermoplastic material, the tube is provided with at least two longitudinal rows of circumferential grooves alternating with longitudinal blank areas as specified in the penultimate paragraph.

Preferred features of the invention will be described with reference to the accompanying drawings, given by way of example, in which:—

Figures 1, 4, 5 and 6 represent four embodiments of the plastic pirn sleeve of the invention;

Figures 2 and 3 represent two embodiments of circumferential or lateral profiles of the grooved indentations in the surface of the pirn sleeve taken at A—A, Figure 1. Figure 2 illustrates a chordal profile and Figure 3 illustrates a lunate profile; and

Figure 7 represents a schematic view of a preferred apparatus of the invention with a part section to show a mandrel.

The plastic pirn sleeves of this invention as described in Figures 1, 4, 5 and 6 have at least two longitudinal rows of grooved indentations in the surface, the rows spaced apart by blank areas that are substantially flush with the ends of the grooves and accompanying "teeth"; the circumferential or lateral profile of the grooves are a chordal or lunate segment of a circle, as shown in Figures 2 and 3. The grooved indentations are spaced in the range of 30 to 70 grooves per inch and having a maximum depth peak to valley of .002" to .010" in the central portion, tapering at the ends to be substantially flush with the blank areas (as shown at B, Figures 2 and 3). The width of the rows of indentations is from 1/32" to 1/2". The grooves may be circumferential or may lie at as much as a 10° angle to the circumference of the sleeve. The rows of grooves may lie essentially parallel to the axis of the sleeve or they may be at an angle of up to 45° spiraling around the sleeve. The rows of indentations may be continuous from end to end of the sleeve or may be broken in shorter strips, as shown in Figure 5.

Preferably the grooves on the pirn sleeve are from 0.004" to 0.006" deep at the central portions, yielding in a 1.75" diameter sleeve, a row width of about 1/8" for a chordal segment and up to 1/2" for a lunal segment. The number of grooves is preferably 40—50 per inch. The number of rows can vary with the width of the rows, the depth of the grooves and with the diameter of the sleeve. preferably there are three to sixteen rows. With a sleeve of 1.75" diameter, six to ten 1/8" wide rows are particularly preferred. With sleeves of 2 to 3 inches in diameter or even larger, a proportionately larger number of rows is desired.

In Fig. 7 a mandrel 10 supports a thermoplastic tube 11. A frame in the form of a flat disc 12 is mounted such that the tube 11 supported by the mandrel 10 passes through a round opening in the centre of the disc 12. Brackets 13, each with round holes 14 whose axes are directed at right angles toward the axis of tube 11, are attached on one side of the flat disc 12. A bolt 18 passes through the hole 14 in each bracket 13 and the end of the bolt nearest the tube 11 is attached to a U bar 17. A rotatable die wheel 15 (one of six as designed) having an axle pin 16 is mounted in each U bar 17, and all the wheels 15 rest on the surface of the tube 11 supported by the mandrel 10. The rims of the die wheels 15 have a grooved contour as desired. Slots 21 in the flat disc 12 are provided (one slot for each die wheel) to act as guides to align the die wheels 15 with the tube 11. A spring 19 on each bolt 18, and compressed between the bracket 13 and the U-bar 17, holds each die wheel 15 against the surface of the tube 11. The magnitude of the springs control the pressure of the die wheels 15 on the tube 11. Wing nuts 20 are provided on bolts 18 for adjustment of the position of the die wheels 15 relative to the tube 11.

In operation, a thermoplastic tube 11, having an external surface temperature above the softening point of the thermoplastic material moves in the direction shown in the drawing between the rotatable die wheels 15 which are pressed against the surface of the tube 11 by the pressure of the springs 19. The required external surface temperature of tube 11 may have been achieved using internal or external radiant heaters, for example, or the tube may have been extruded from an extruder and only partially cooled. This cooling may be effected by providing the mandrel with means for cooling the hot extruded tube. As the die wheels 15 roll on the surface of tube 11, (parallel to the longitudinal axis of the tube), the indentations on the rims of the die wheels 15 are permanently impressed into the surface of tube 11. Means for further cooling the tube after indentation may also be provided if desired. The maximum depth of the die wheel impressions is controlled by the adjustment of wing nuts 20. It is appreciated that the springs 19 may be replaced by other equivalent means for regulating the pressure of the die wheels 15 on the tube 11. for example air of hydraulic cylinders.

The tube may be moved over a stationary mandrel between the rotatable die wheels;

the tube may be moved on and with a mandrel between the rotatable die wheels; or the mandrel and the tube may be kept stationary while the frame on which the rotatable die wheels are located is moved along the tube. If desired a specific means for pulling the tube over the mandrel and between the die wheels may be employed.

The die wheels can be used as idlers or can be driven to form part or all of a mechanism to propel the tubing along the mandrel. The frame 12 for the die wheels, in turn can be rotated so that the rows of indentations are placed in a helical rather than straight track. The die wheels may be located in frame 12 not only as shown in Figure 7, but they can also be located in dual frames in a staggered relationship so that the tracks of the die wheels can be more closely spaced though still apart by blank areas, or they can be grouped together in combinations of two or more tracks, side by side, with blank areas only between the combinations, producing a pattern as shown in Figure 6.

Various modifications of the above embodiment of the present invention may be employed. For example, the thermoplastic tube 11 need not have an external surface temperature above the softening point of the thermoplastic material when it moves in the direction shown in the drawing. The required external surface temperature of the tube may be achieved by making mandrel 10 a heating mandrel or die wheels 15 may be heated sufficiently to indent the surface of an unheated tube. Means may also be provided for cutting the tubing into predetermined lengths.

Tubes made from various thermoplastic materials may be indented according to the present invention; for example, those made from polyethylene, polypropylene, polyvinyl chloride and its copolymers, celluloses such as cellulose acetate butyrate, or an acrylonitrile - butadiene - styrene material (known as ABS resin).

The surface of the rims in the axial direction of the die wheels used to indent thermoplastic tubes according to the present invention is preferably flat in shape. Rims slightly convex or slightly concave are acceptable. However, a scuffing effect (due to unequal surface speeds between the middle and the outside edges of the rim) may occur if the concave curvature of the rims is too great. A slightly convex rim provides a lenticular groove and a slightly concave rim provides a lunate groove. Die wheels with a flat axial face produced grooves in the tubing that have a lateral profile that is chordal, as in Figure 2.

The patterning on the surface of the die wheels can be continuous or it can be interrupted, for example, so as to produce the rows of indentations in the style shown in Figure 5.

The surface of the die wheels can carry transverse "teeth"-grooves of 30—70 per inch. These "teeth"-grooves may be of triangular, rounded or sinusoidal wave in cross section. The resulting indentations in the tubing, depending upon dwell-time, pressure, temperature and character of the polymer, may be the same or differ in cross section from the profile of the die wheel. For example, a triangular tooth on the die can mold a flat-bottomed groove with a semicircular mound between grooves. This style aids filament release. The flat bottomed groove can vary in width and for some applications the width of this groove will be almost insignificant.

The surface temperature of the thermoplastic tube at the point of indentation varies according to the type of thermoplastic material. Each type and grade of plastic has a different temperature range at which the tube is soft enough to permanently deform but hard enough to withstand the strains on its overall dimensional stability and uniformity imposed by the marking process. A tube of ABS pipe grade resin, for example, requires a surface temperature in the range of 350°F to 375°F during indentation.

Alternatively, the pirn sleeves of this invention can be produced by replacing the die wheels by flat, patterned dies pressed against the tubing. These may take the form of patterned metal belts which roll in contact with the tubing and can serve at the same time as a pulling mechanism, or by engraved bars which move in a reciprocating fashion. In another variation, a heated wire grid can be pressed tangentially across the surface of the tubing to produce a row of grooves. In yet another variation helical threaded rollers or cutters rotating parallel with the axis of the pirn sleeves can be induced to impress a grooved pattern in the sleeve surface.

For some design of pirns a beading of one end of the sleeve is desirable. This can be done, for example, by heating one end of the tubing and forcing the softened end of the tubing into an inverting mold which forced the tube to turn in on inself about 180° to form a smooth bead about 1/8" wide.

The present invention may be further illustrated by the following Example.

Example

An ABS pipe grade resin tube having an outside diameter of about 1 3/4" in a wall thickness of about 0.020" was continuously extruded from an evtruder at a temperature of about 360°F. After extrusion, a haul-off mechanism pulled the tube over a stationary cooling mandrel (the mandrel being sup-

ported by the extruder), through a stationary frame supporting six rotatable die wheels of the type illustrated in the drawing equispaced about the external surface of the tube, and then through a cooling shroud. The tube was then cut in predetermined lengths to be used as sleeves for textile pirns. Each die wheel had a 1/4" wide cylindrical rim indented as follows: 45 grooves per inch running axially across the rim; the peak to valley height of the grooves being 0.006". The temperature of the external surface of the tube at the point of indentation was approximately 360°F. Each pirn sleeve produced above had six parallel 1/4" wide indented strips, corresponding to the rims of the six die wheels, running the entire length of the pirn, see Fig.1. The pirn sleeves were subsequently fitted on pirns and yarn was wound thereon. No internal sloughing of the yarn wound on these pirn sleeves was detected.

WHAT WE CLAIM IS:—

1. A plastic pirn sleeve which comprises a tube carrying at least two longitudinal rows of substantially circumferential grooves alternating with longitudinal blank areas, the grooves having a profile that is chordal, lunate, or lenticular with a maximum depth peak-to-valley of 0.002" to 0.010" and tapering at either end to be substantially flush with the blank areas, the grooves being spaced substantially uniformly to provide from 30 to 70 grooves per inch, and the longitudinal rows being from 1/32" to 1/2" wide.

2. A plastic pirn sleeve according to claim 1 wherein the maximum depth of the grooves is 0.004" to 0.0006".

3. A plastic pirn sleeve according to claim 1 or 2 wherein the grooves are spaced so as to provide from 40 to 50 grooves per inch.

4. A process for indenting the external surface of a thermoplastic tube which comprises moving at least two die units each in a separate path along the length of the external surface of a thermoplastic tube while the tube is supported on a mandrel, and pressing the die units against the surface of the tube, whilst the tube is at a temperature above the softening point of the thermoplastic material, to form at least two longitudinal rows of permanent substantially circumferential grooves therein alternating with longitudinal blank areas, the grooves having a profile that is chordal, lunate, or lenticular with a maximum depth peak to valley of 0.002" to 0.010" and tapering at either end to be substantially flush with the blank areas, the grooves being spaced substantially uniformly to provide from 30 to 70 grooves per inch, and the longitudinal rows being from 1/32" to 1/2" wide.

5. A process according to claim 4 in which the die units are a wire grid.

6. Process according to claim 4 in which the die units are engraved bars moving in a reciprocating fashion.

7. A process according to claim 4 wherein the die units are wheels.

8. A process according to claim 7 wherein the tube is moved over a stationary mandrel and through a stationary frame supporting the die wheels, the die wheels being evenly spaced about the tube substantially in a plane perpendicular to the axis of the tube.

9. A process according to claim 7 wherein the tube is moved on and with a mandrel through a stationary frame supporting the die wheels, the die wheels being evenly spaced about the tube substantially in a plane perpendicular to the axis of the tube.

10. A process according to claim 7 wherein a frame supporting the die wheels is moved over the tube which is held stationary on a stationary mandrel, the die wheels being evenly spaced about the tube substantially in a plane perpendicular to the axis of the tube.

11. A process according to any of claims 7 to 10 wherein the die wheels are heated.

12. A process according to any of claims 4 to 10 which additionally comprises initially extruding the tube in a continuous length to provide a heated tube, thereafter cooling the tube until the external surface of the tube is at a temperature suitable for the formation of the grooves therein, and further cooling the tube after the formation of the grooves.

13. A process according to any of claims 4 to 12 wherein the tube is subsequently cut into lengths.

14. A process according to any of claims 4 to 13 wherein the thermoplastic tube is made from ABS resin.

15. An apparatus for indenting the external surface of a thermoplastic tube, which comprises a mandrel and at least two rotatable die wheels located about the mandrel, the mandrel being adapted to support a thermoplastic tube, each die wheel having a rim with indentations thereon and being adapted to roll on the surface of the tube in a longitudinal direction and pressure means adapted to hold each wheel against the tube; the indentations being such that when the wheels roll against the surface of the thermoplastic tube, when the latter is at a temperature above the softening point of the thermoplastic material, the tube is provided with at least two longitudinal rows of substantially circumferential grooves alternating with longitudinal blank areas as specified in claim 1.

16. An apparatus according to claim 13 wherein the mandrel is stationary, and the

rotatable die wheels are mounted on a stationary frame surrounding the mandrel.

17. An apparatus according to claim 15 or claim 16 wherein means are provided for heating the rotatable die wheels.

18. An apparatus according to any of claims 15 to 17 which additionally comprises an extruder adapted to extrude the tube continuously, a first cooling means adapted to cool the tube prior to the indenting of the surface thereof, a second cooling means adapted to cool the tube further after the indenting of the surface thereof, and pulling means for the continuously extended tube.

19. An apparatus according to claim 18 wherein the first cooling means and the mandrel are combined in the form of a cooling mandrel.

20. An apparatus according to any of claims 15 to 19 which additionally comprises cutting means to cut the tube into predetermined lengths.

21. An apparatus according to any of claims 15 to 20 when provided with from six to ten rotatable die wheels.

22. An apparatus for indenting the external surface of a thermoplastic tube substantially as hereinbefore described with reference to Figure 7 of the accompanying drawings.

23. A process for indenting the external surface of a thermoplastic tube substantially as hereinbefore described with reference to Figure 7 of the accompanying drawings and/or the Example.

24. An indented tube when prepared by the process of any of claims 4 to 14 or 23, or in the apparatus of any of claim 15 to 22.

25. A plastic pirn sleeve substantially as hereinbefore described with reference to any of Figures 1, 4, 5, or 6 or such Figures when modified by Figure 2 or 3 of the accompanying drawings.

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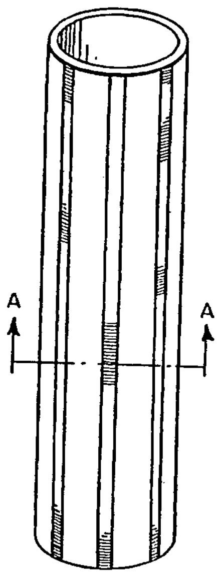

FIG. 1

FIG. 2

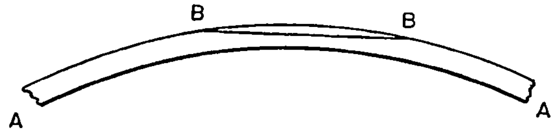

FIG. 3

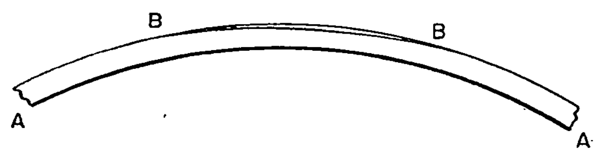

FIG. 4

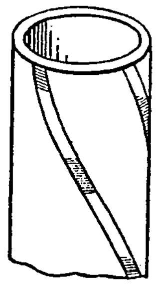

FIG. 5

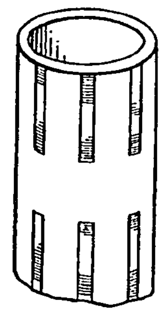

FIG. 6

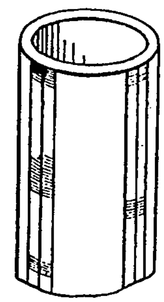

FIG. 7